FULL TITLE
*ASP Conference Series, Vol. **VOLUME**, **YEAR OF PUBLICATION***
NAMES OF EDITORS

The Influence of X-ray Emission on the Stellar Wind of O Stars

Jiří Krtička

Ústav teoretické fyziky a astrofyziky, Přírodovědecká fakulta Masarykovy univerzity, Kotlářská 2, CZ-611 37 Brno, Czech Republic

Jiří Kubát

Astronomický ústav, Akademie věd České republiky, CZ-251 65 Ondřejov, Czech Republic

Abstract. We study the influence of X-ray radiation on the wind parameters of O stars. For this purpose we use our own NLTE wind code. The X-ray emission (assumed to be generated in wind shocks) is treated as an input quantity. We study its influence on the mass-loss rate, terminal velocity and ionization state of the stellar wind of Galactic O stars.

1. Introduction

From the observation of hot stars it is known that they emit X-ray radiation (e.g. Berghöfer et al., 1996, hereafter BSC). O star X-ray luminosity L_{X} scales with stellar luminosity L roughly as $L_{\mathrm{X}} \approx 10^{-7}L$. The X-rays in O stars are generated most likely by shocks that emerge in the supersonic stellar wind either due to the wind instability (Feldmeier et al. 1997) or due to the stellar magnetic field (ud-Doula & Owocki 2002).

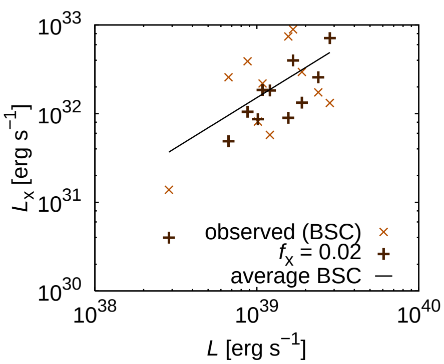
2. Wind models

NLTE stationary spherically symmetric wind models applied here were described by Krtička & Kubát (2004). To enable reliable calculation of wind models in the case when strong source of X-ray radiation is present, we included also the Auger ionization into NLTE equations and we extended the set of model ionization stages.

We assume that a part of wind material is heated by the shock to a very high temperature of the order of 10^6 K. The shock temperature is given by the Rankine-Hugoniot shock condition. We assume that shock velocity difference is proportional to the wind velocity with the multiplicative coefficient as a free parameter. The density of heated material ρ_{x} is related to the ambient wind density ρ by $\rho_{\mathrm{x}} = f_{\mathrm{x}}^{1/2}\rho$ where f_{x} is the fillig factor (second free parameter). We include the shock emissivity into a corresponding emission coefficient.

Parameters of studied O stars were adopted from Repolust et al. (2004), Markova et al. (2003) and Lamers et al. (1995). X-ray luminosities are from BSC.

3. The origin of $L_{\mathrm{x}} \sim 10^{-7} L$ relation



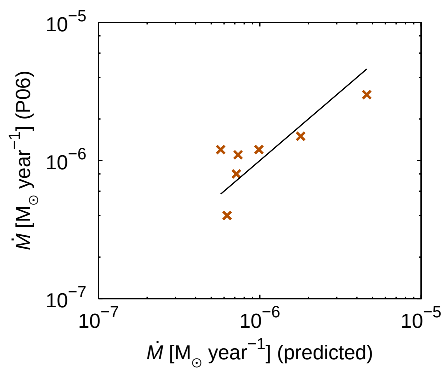


Figure 1. Left panel: Comparison of a calculated and observed X-ray luminosity ($f_{\mathrm{x}} = 0.02$). Right panel: Comparison of predicted mass-loss rates $\dot{M}$ and its upper limits derived from observation by Puls et al. (2006, P06 in the figure). Note a good agreement between these rates.

We calculated models with the same filling factor $f_{\mathrm{x}} = 0.02$ for all stars (see Fig. 1). For stars with luminosities $L \gtrsim 10^{39}\,\mathrm{erg\,s^{-1}}$ this relativelly well resembles the relation between L_{x} and L derived by BSC.

4. Influence of X-rays on wind parameters

Because the mass loss rate is determined at low wind velocities (where the ionization state is not significantly influenced by X-rays), the O star mass-loss rate is not influenced by the presence of X-rays. This may change for stars with lower luminosities or for stars with weaker ionizing radiation, i.e. for B stars.

X-rays are generated in the outer wind regions and do not penetrate deep into the inner ones. Because in these outer regions the terminal velocity is being determined, the presence of X-rays may influence its value (especially for stars with lower effective temperature) due to changed ionization in the outer wind.

Acknowledgments. Grants GA ČR 205/03/D020, 205/04/1267.

References

Berghöfer, T. W., Schmitt, J. H. M. M., & Cassinelli, J. P., 1996, A&AS, 118, 481 (BSC)
Feldmeier, A., Puls, J., & Pauldrach, A. W. A., 1997, A&A, 322, 878
Krtička, J., & Kubát, J., 2004, A&A, 417, 1003
Lamers, H. J. G. L. M., Snow, T. P., & Lindholm, D. M., 1995, ApJ, 455, 269
Markova, N., Puls, J., Repolust, T., & Markov, H., 2004, A&A, 413, 693
Puls, J., Markova, N., Scuderi, S., et al., 2006, A&A, in press (P06)
Repolust, T., Puls, J., & Herrero, A., 2004, A&A, 415, 349
ud-Doula, A., & Owocki, S. P., 2002, ApJ, 576, 413